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EXAMINER

MALDONADO, JULIO J

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 07/08/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/521,389

Applicant(s)

OKAMOTO, SHIGERU

Examiner

Julio J. Maldonado

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 17 April 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-7 and 37-49 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-7 and 37-49 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

1. The non-final rejection as set forth in paper No.16 is withdrawn in response to applicants' request for reconsideration.
2. Claims 45-49 are newly added.
3. A new 103(a) rejection is made as set forth in this Office Action.
4. Claims 1-7 and 37-49 are pending in the application.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

6. Claims 48 and 49 rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claims 48 and 49 cite, "...wherein said metal growth promoting layer is a TiN layer including substantially no oxygen except at its surface due to said TiN layer being formed by chemical vapor deposition (CVD) process...". However, there is no mention of forming TiN having "no oxygen except at its surface due to said TiN layer being formed by chemical vapor deposition (CVD) process" as claimed.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1, 3-7 and 44 are rejected under 35 U.S.C. 102(b) as being anticipated by Stevens (U.S. 5,070,036).

Stevens (Fig.1) teaches an interconnecting semiconductor device comprising any one of an opening part (3) or depressed part formed in an insulating layer (2) on a substrate (1); a barrier layer (6) covering said opening part (3) or depressed part, said barrier layer being made of a first material; a metal growth promoting layer (7) formed directly on said barrier layer (6), wherein said metal growth promoting layer comprises titanium nitride containing a lower oxygen concentration than said barrier layer (6) and is different from said first material; and an electroconductive layer (8, 9) comprising aluminum embedded in said opening part (3) or said depressed part via said barrier layer (6) and said metal growth promoting layer (7), wherein said electroconductive layer (8, 9) being formed directly on said metal growth promoting layer (7) and wherein said barrier layer (6) and said growth promoting layer (7) comprises a ground layer comprising titanium nitride containing oxygen at a high concentration at a lower part and at a low concentration in the upper part thereof (column 6, line 66 – column 11, line 61).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

10. Claims 2, 40 and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Stevens ('036) in view of Hoshino (U.S. 4,910,169).

Stevens (Fig.1) teaches an interconnecting semiconductor device comprising any one of an opening part (3) or depressed part formed in an insulating layer (2) on a substrate (1); a barrier layer (6) covering said opening part (3) or depressed part, said barrier layer being made of a first material; a metal growth promoting layer (7) formed directly on said barrier layer (6), wherein said metal growth promoting layer comprises titanium nitride containing a lower oxygen concentration than said barrier layer (6) and is different from said first material; and an electroconductive layer (8, 9) comprising aluminum embedded in said opening part (3) or said depressed part via said barrier layer (6) and said metal growth promoting layer (7), wherein said electroconductive layer (8, 9) being formed directly on said metal growth promoting layer (7) and wherein said barrier layer (6) and said growth promoting layer (7) comprises a ground layer comprising titanium nitride containing oxygen at a high concentration at a lower part and at a low concentration in the upper part thereof (column 6, line 66 – column 11, line 61).

Stevens fails to teach selecting the barrier layer from the group consisting of WN_x and TaN_x , wherein x is a variable such that $0 \leq x \leq 1$. However, Hoshino (Fig.1A) in a

related art to the formation of an interconnect structure teaches a barrier layer selected from the group consisting of WN_x and TaN_x , wherein x is a variable such that $0 \leq x \leq 1$ (column 2, line 65 – column 3, line 18). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to include a barrier layer as taught by Hoshino in the interconnect structure of Stevens, since this would prevent diffusion between layers (column 3, lines 4-9).

11. Claim 37 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stevens ('036).

Stevens (Fig.1) teaches an interconnecting semiconductor device comprising any one of an opening part (3) or depressed part formed in an insulating layer (2) on a substrate (1); a barrier layer (6) covering said opening part (3) or depressed part, said barrier layer being made of a first material; a metal growth promoting layer (7) formed directly on said barrier layer (6), wherein said metal growth promoting layer comprises titanium nitride containing a lower oxygen concentration than said barrier layer (6) and is different from said first material and said metal growth promoting layer having a thickness between .005 to 0.2 micrometers; and an electroconductive layer (8, 9) comprising aluminum embedded in said opening part (3) or said depressed part via said barrier layer (6) and said metal growth promoting layer (7), wherein said electroconductive layer (8, 9) being formed directly on said metal growth promoting layer (7) and wherein said barrier layer (6) and said growth promoting layer (7) comprises a ground layer comprising titanium nitride containing oxygen at a high

concentration at a lower part and at a low concentration in the upper part thereof (column 6, line 66 – column 11, line 61).

However, Stevens fails to teach the metal growth promoting layer having a thickness of at least approximately 10nm. Notwithstanding, it would have been an obvious matter of design choice bounded by well known manufacturing constraints and ascertainable by routine experimentation and optimization to choose these particular dimensions because applicant has not disclosed that the dimensions are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical, and it appears *prima facie* that the process would possess utility using another dimension. Indeed, it has been held that mere dimensional limitations are *prima facie* obvious absent a disclosure that the limitations are for a particular unobvious purpose, produce an unexpected result, or are otherwise critical. See, for example, *In re Rose*, 220 F.2d 459, 105 USPQ 237 (CCPA 1955); *In re Rinehart*, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976); *Gardner v. TEC Systems, Inc.*, 725 F.2d 1338, 220 USPQ 777 (Fed. Cir. 1984), cert. denied, 469 U.S. 830, 225 USPQ 232 (1984); *In re Dailey*, 357 F.2d 669, 149 USPQ 47 (CCPA 1966).

12. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stevens ('036) in view of Lee (U.S. 5,552,341).

Stevens (Fig.1) teaches an interconnecting semiconductor device comprising any one of an opening part (3) or depressed part formed in an insulating layer (2) on a substrate (1); a barrier layer (6) covering said opening part (3) or depressed part, said barrier layer being made of a first material; a metal growth promoting layer (7) formed

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directly on said barrier layer (6), wherein said metal growth promoting layer comprises titanium nitride containing a lower oxygen concentration than said barrier layer (6) and is different from said first material; and an electroconductive layer (8, 9) comprising aluminum embedded in said opening part (3) or said depressed part via said barrier layer (6) and said metal growth promoting layer (7), wherein said electroconductive layer (8, 9) being formed directly on said metal growth promoting layer (7) and wherein said barrier layer (6) and said growth promoting layer (7) comprises a ground layer comprising titanium nitride containing oxygen at a high concentration at a lower part and at a low concentration in the upper part thereof (column 6, line 66 – column 11, line 61).

Stevens fails to show the barrier layer comprises TiSiN. However, Lee (Fig.9) teaches an interconnect device including a barrier layer comprising TiSiN (column 10, lines 6-24). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to include a barrier layer as taught by Lee in the interconnect structure of Stevens, since this would improve the step coverage of the metallic interconnect (column 8, lines 13-24).

13. Claims 43 and 45-47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Stevens ('036) in view of Mu et al. (U.S. 5,612,254).

Stevens (Fig.1) teaches an interconnecting semiconductor device comprising any one of an opening part (3) or depressed part formed in an insulating layer (2) on a substrate (1); a barrier layer (6) covering said opening part (3) or depressed part, said barrier layer being made of a first material; a metal growth promoting layer (7) formed directly on said barrier layer (6), wherein said metal growth promoting layer comprises

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titanium nitride containing a lower oxygen concentration than said barrier layer (6) and is different from said first material; and an electroconductive layer (8, 9) comprising aluminum embedded in said opening part (3) or said depressed part via said barrier layer (6) and said metal growth promoting layer (7), wherein said electroconductive layer (8, 9) being formed directly on said metal growth promoting layer (7) and wherein said barrier layer (6) and said growth promoting layer (7) comprises a ground layer comprising titanium nitride containing oxygen at a high concentration at a lower part and at a low concentration in the upper part thereof (column 6, line 66 – column 11, line 61).

Stevens fails to show a diffusion barrier comprising Al_2O_3 and wherein said electroconductive layer is a copper. However, Mu et al. teach an interconnect structure comprising a barrier layer (not shown) comprising aluminum oxide and an electroconductive layer selected from the group comprising copper and aluminum (column 4, lines 38-55). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to include the barrier layer as taught by Mu et al. in the interconnect structure of Stevens, since it would prevent diffusion between layers in the interconnect device (column 4, lines 38 – 55). It would also have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of Stevens and Mu et al. to enable the electroconductive layer to be a copper layer.

Response to Arguments

14. Applicant's arguments filed 4/17/2003 have been fully considered but they are not persuasive.

Applicant argues, "... Stevens, layer 9, which is the layer that most closely resembles the claimed electroconductive layer, is not formed directly on layer 7, which is the layer that the Examiner has equated with the claimed growth promoting layer. Instead, layer 8, which comprises silicon dissolved to the saturation concentration in an aluminum titanium compound...is located between layers 7 and 9. Accordingly, layer 9 is not "formed directly" on layer 7...". In response to this argument, in the action mailed on 11/18/2002, layers 8 and 9 of Stevens were equated with the claimed electroconductive layer, not layer 9 alone.

Conclusion


15. Papers related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 305-3432**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Julio J. Maldonado** at **(703) 306-0098** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via julio.maldonado@uspto.gov. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri, can be reached on (703) 306-2794.

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Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.

JMR
6/25/03



George Fourson
Primary Examiner